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December 1985

ISSUES IN FISHERIES HABITAT CONSERVATION AND RESEARCH FOR THE HAWAIIAN ARCHIPELAGO AND CENTRAL PACIFIC

Results of a Planning Workshop 27–28 June 1985

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Not for Publication

ADMINISTRATIVE REPORT H-85-10

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Southwest Fisheries Center Administrative Report H-85-10

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INTRODUCTION

A critical component of fisheries research involves understanding the ecosystem which supports productivity of fisheries resources. The habitat of a given resource extends far beyond the environment in which it is captured; it involves the underlying trophic structure, larval and juvenile habitats, and species interactions. As scientists have developed a better appreciation of habitat-related issues, their importance to the fisheries management process has become evident. Man's activities have significant impacts on the marine environment and an understanding of the nature of habitat is necessary to evaluate the effects upon fisheries resources and protected species.

Funds were appropriated for NOAA's National Marine Fisheries Service (NMFS) in fiscal year 1985 with the intent of developing a program of "vital fisheries habitat research in the Pacific." The field laboratory responsible for this work is the Southwest Fisheries Center (SWFC) Honolulu Laboratory (HL). In response, a preliminary plan was developed through discussion by several scientists at HL and modified at a joint meeting between personnel of the HL and the Southwest Region (SWR) Western Pacific Program Office (WPPO) held 27 July 1984. Information on policy documents used for guidance in program implementation is shown in Appendix 1. A framework task development plan and current year operating plan were subsequently developed.

The purpose of holding the interagency planning workshop described herein was to clarify the important issues, identify problems that might have been overlooked, explore areas of cooperative research and generally increase interaction and communication between the organizations concerned with habitat related issues.

This report describes the planning meeting and presents the preliminary results of the deliberations. It is hoped that the information presented here will be of value to others as well as the NMFS in developing further programs for habitat research and conservation.

THE STRUCTURE OF THE PLANNING MEETING

Objectives

The meeting was designed with five major related objectives or desirable outcomes in mind:

1. To determine the current and emerging issues in fisheries habitat conservation and research in the Hawaiian Archipelago and Pacific islands.

2. To identify issues that fall within the purview of the NMFS-SWFC-HL missions.

3. To select those issues for which HL research programs need to be designed.

4. To formulate research objectives that, if accomplished, would provide the information required to resolve the issues.

5. To develop research activities or events that need to be accomplished to meet the objectives.

Participants

Because the abilities and the knowledge required to meet these objectives did not exist entirely within HL, experts from other agencies who could represent several different perspectives and scientific disciplines were invited to help in the planning process.

In addition to those task leaders at the HL that would be directly involved in fisheries habitat research, representatives of NMFS laboratories and offices involved in fisheries habitat research, evaluation and planning were invited (i.e., La Jolla Laboratory, Tiburon Laboratory, Office of Resource Investigations, WPPO). Also, we attempted to include experts from outside agencies that are most directly involved with the issues in question. The invitees included representatives of the Hawaii Department of Land and Natural Resources (DLNR) Division of Aquatic Resources, Hawaii Department of Planning and Economic Development (DPED) Ocean Resources Branch, and the University of Hawaii (UH).

Though a larger group would have included more viewpoints, we judged that in this early phase of planning the 13 selected participants (Appendix 2) could effectively identify and articulate the important issues. As the HL's program planning develops, the interests, roles and responsibilities of agencies not represented at this meeting may overlap our own; opportunities for cooperative action could thus be developed. It is with this hope that copies of this report will be distributed to insure input into the ongoing planning process. Before the meeting, each participant was provided with a tentative agenda and background material concerning the current program and NMFS habitat policy (see Appendix 3).

The Process of the Meeting

After introductory material was presented and the meeting structure and process defined (see Meeting Agenda, Appendix 4), the group participated in the process of Nominal Group Technique (NGT) to consider the stated objective of identifying major habitat issues in the Hawaiian Archipelago and the central Pacific. Issues in this process were defined in light of the following trigger question:

"In the context of developing a 5-6 year research program what are the important current and emerging issues (problems, threats, man-induced, non man-induced) concerning central and western Pacific fisheries habitat that need to be resolved?"

Listing of the ideas and issues was followed by group discussion designed to clarify each issue, combine or modify overlapping ones, and to determine which issues were most relevant to the mission of the NMFS; the issues, together with a short discussion of each, are shown in Appendix 5. Finally, the most important issues were selected by voting (Appendix 6) and were then structured using a computer assisted technique called Interpretive Structural Modeling (ISM), ending the first day's work. The second day began with discussion of the resultant structure and the interrelatedness of the various issues, definition of the major topical areas, and assignment of participants to subgroups which were charged with development of ideas and reports on the specific topical areas. Finally, the full group reconvened to hear the subgroup reports and to comment on them.

STRUCTURE OF THE HABITAT RESEARCH ISSUES

The interactive computer program produced a preliminary chart showing the relationships among the issues described in Appendix 5. This preliminary chart (Fig. 1) shows the interrelationships among the issues. Major topical areas closely interrelated were identified for further elucidation by subgroups; these six topical areas are grouped in Figure 2:

1) Baseline studies
2) Long-term ecological research
3) Habitat inventory
4) Mitigation and artificial reefs
5) Ocean Thermal Energy Conversion (OTEC)
6) Ocean mining and dumping

These topical areas are considered separately below. For each there is defined one to three major objectives to follow by a list of Significant Events to be achieved over the proposed 5-6 years of study.

SUBGROUP WORK

Each subgroup produced two main products:

1. A list of 1-3 **Major Objectives** for each program.

2. A list of **Significant Events** to be completed over the 5-6 years of study. If reached, these would demonstrate that substantial progress was being made toward the objectives for each program.

A secondary objective was to review the structural chart (Fig. 1) and to make recommendations on revisions.

HABITAT ISSUES

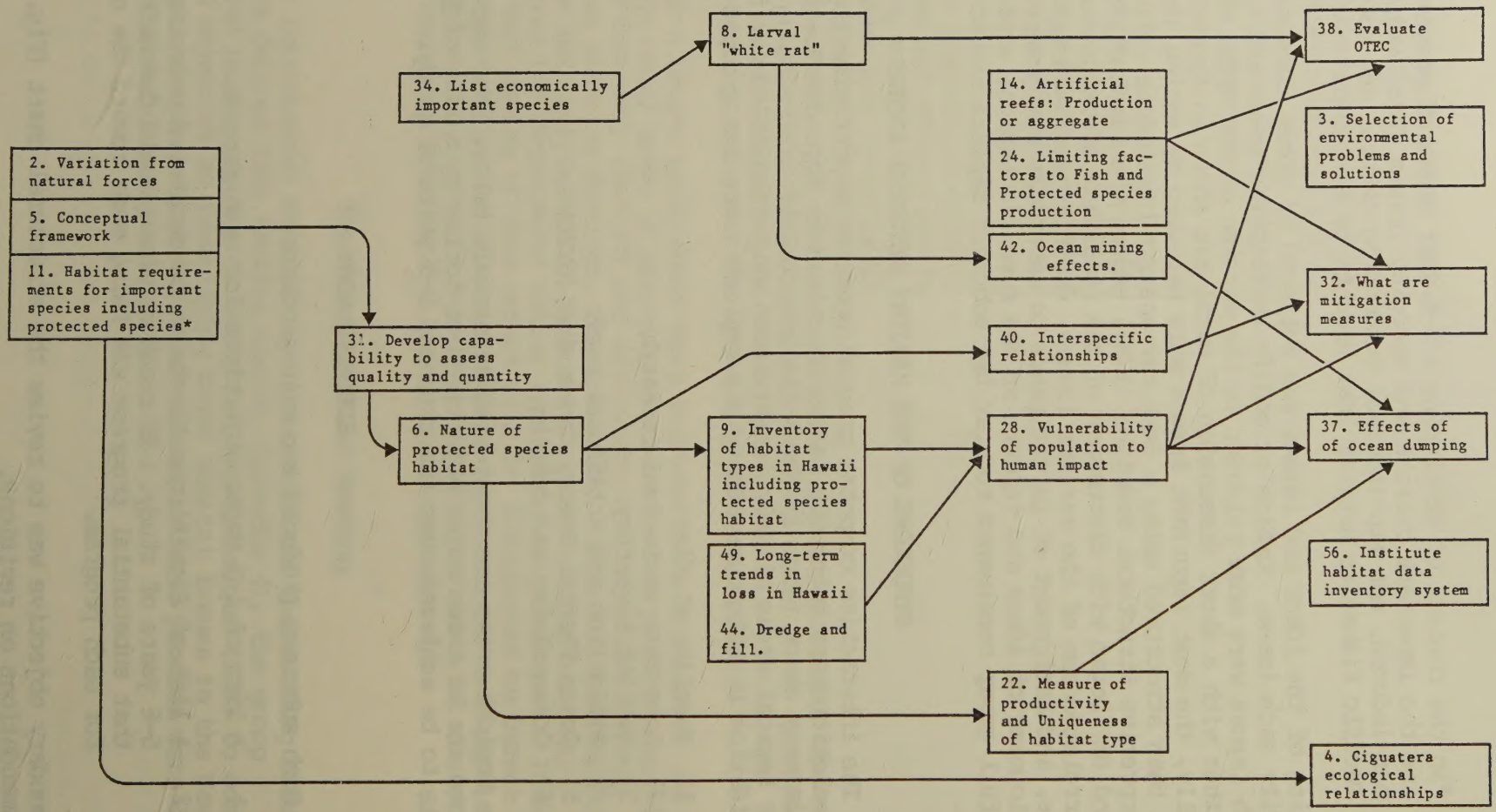
2. Variation from natural forces
5. Conceptual framework
11. Habitat requirements for important species including protected species*
34. List economically important species
8. Larval "white rat"
31. Develop capability to assess quality and quantity
6. Nature of protected species habitat
9. Inventory of habitat types in Hawaii including protected species habitat
49. Long-term trends in loss in Hawaii
44. Dredge and fill.
14. Artificial reefs: Production or aggregate
24. Limiting factors to Fish and Protected species production
42. Ocean mining effects.
40. Interspecific relationships
28. Vulnerability of population to human impact
22. Measure of productivity and Uniqueness of habitat type
4. Ciguatera ecological relationships
38. Evaluate OTEC
3. Selection of environmental problems and solutions
32. What are mitigation measures
37. Effects of of ocean dumping
56. Institute habitat data inventory system

Figure 1

HABITAT ISSUES

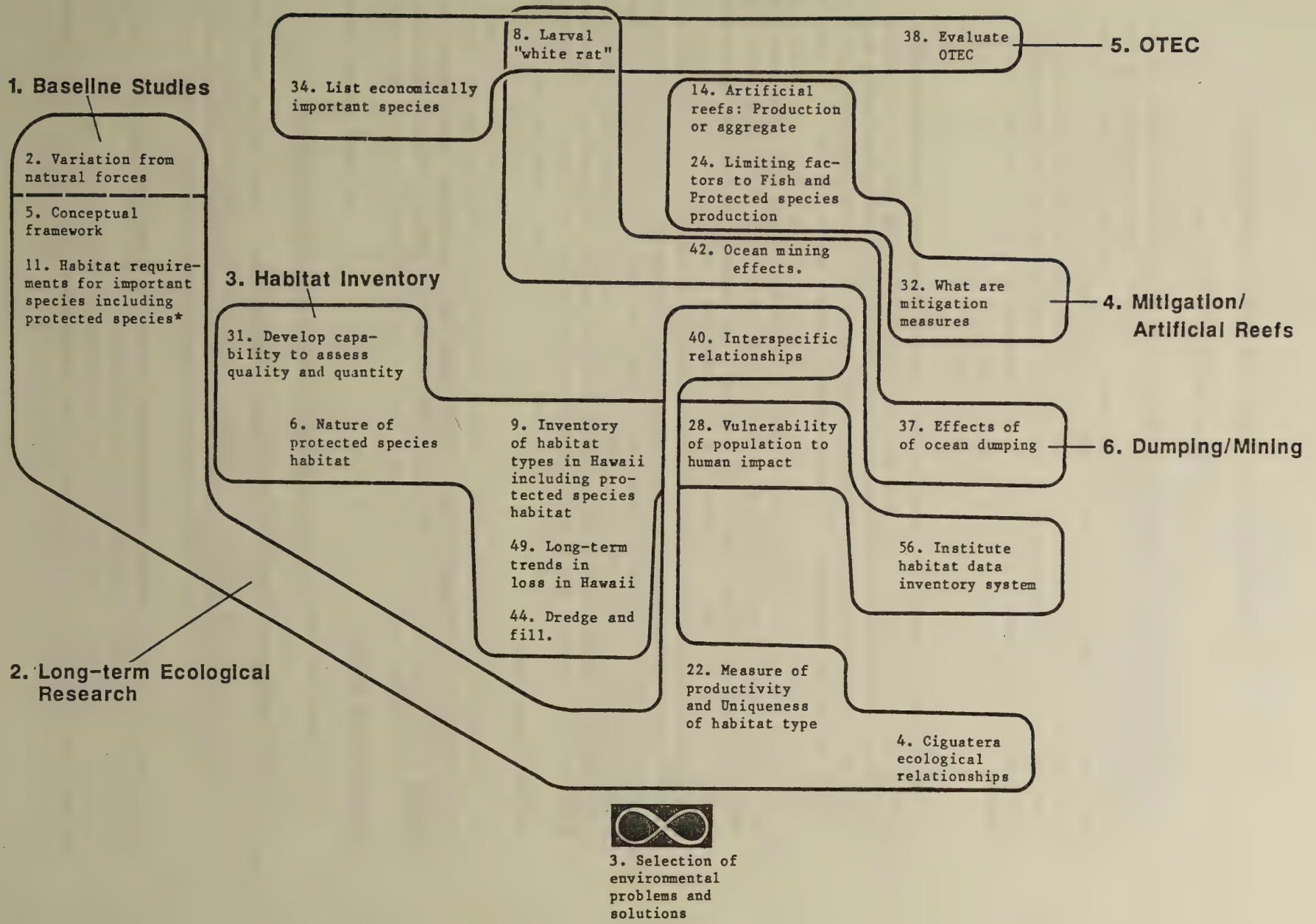
1. Baseline Studies
2. Variation from natural forces
5. Conceptual framework
11. Habitat requirements for important species including protected species*
3. Habitat Inventory
31. Develop capability to assess quality and quantity
6. Nature of protected species habitat
9. Inventory of habitat types in Hawaii including protected species habitat
49. Long-term trends in loss in Hawaii
44. Dredge and fill.
2. Long-term Ecological Research
34. List economically important species
8. Larval "white rat"
38. Evaluate OTEC
5. OTEC
14. Artificial reefs: Production or aggregate
24. Limiting factors to Fish and Protected species production
42. Ocean mining effects.
32. What are mitigation measures
4. Mitigation/ Artificial Reefs
40. Interspecific relationships
28. Vulnerability of population to human impact
37. Effects of of ocean dumping
6. Dumping/Mining
56. Institute habitat data inventory system
22. Measure of productivity and Uniqueness of habitat type
4. Ciguatera ecological relationships
3. Selection of environmental problems and solutions

Figure 2

ORGANIZATION OF FISHERIES HABITAT RESEARCH

1. Baseline Studies

The importance of baseline studies has been established. An example of valuable baseline information is the lobster data gathered by the Townsend Cromwell before the development of a lobster fishery in the Northwestern Hawaiian Islands. Recent dramatic changes in the fishery have been noted. The baseline area can be resurveyed to determine actual changes in the population as a result of the fishery. As an example, the turtle habitat survey currently being conducted will provide a means to measure the impact of future disturbances.

This subgroup studied that portion of the initial structural chart (Fig. 1) that showed the relationships among various items related to long-term ecological studies. The group agreed that we cannot begin to evaluate the importance of human disturbance until we understand the range of natural variation in the environment. Specifically we might ask what variation can be expected from natural forces (issue 2).

The habitat inventory and baseline studies previously discussed would be useful in making decisions on which environmental parameters to monitor. Two other issues are closely related to this one. We should develop a conceptual model for all possible outcomes of resource and habitat interactions (issue 5). Use of this conceptual model would facilitate decisions concerning which parameters should be monitored. The second related issue is "What are habitat requirements for important species (including protected species) (issue 11)?" Knowing the habitat requirements would also be of great benefit in deciding which parameters to monitor.

Major Objectives

Determine range of natural biotic and abiotic variation in the environment of major marine species, including protected species. The major marine species include the "key" or "indicator" species within a given habitat.

Significant Events

1. Review available information (data and literature).

2. Inventory possible habitats and species.

3. Identify appropriate habitats and representative biological components suitable for long-term study.

4. Identify habitat and community characteristics to be monitored on a long-term basis. For example:

   - physical characteristics of habitats

- standing crop

- species and community structure

5. Selection of habitats, species, and physical characteristics to be monitored.

6. Sampling framework established.

7. Monitoring program in effect.

2. Long-Term Ecological Research

There was consensus that long-term ecological research must be conducted if the goals of the fisheries habitat program are to be attained. A great deal of ecological research remains to be done before we have sufficient knowledge to properly manage these ecosystems. Much of the concern is that we do not really understand the habitat requirements of important species, limits of survival, optimum range of habitat conditions, and the nature of many interspecific interactions. It was recommended that this area be given high priority. Clearly, more basic information is needed before we can begin to use these data for habitat management purposes.

This is a broad area of research and specific objectives and events are more difficult to define. The group as a whole had a clear understanding of this problem and endorsed more effort in basic ecological studies. One example of an ongoing long-term NMFS study is the project conducted by the Fish Communities Investigation of the SWFC Tiburon Laboratory, which is comparing the dynamics of fish communities off the Kona coast of Hawaii with that of temperate ecosystems.

Major Objectives

Determine biotic and abiotic habitat requirements of important living marine resources (species of concern), including protected species. Determine dynamic interactions of key components of the ecosystem.

Significant Events

1. Establish criteria for selecting species.

The program is faced with limited resources, so it will be important to be selective about which species are studied. Perhaps studies should not be limited to economically important species or forage species if others are better indicators of habitat quality.

2. Define limits of survival of important living marine resources.

A logical place to start is defining lethal limits of species that are economically important; studies should, however, be conducted on species judged most likely to provide insights on habitat condition.

3. Define the optimum conditions for important marine resources.

Establishment of lethal limits is not the final answer in fisheries habitat research because any departure from optimum conditions will reduce production. The optimum is much more difficult to establish, but research must move in that direction.

4. Define interspecific interactions.

Little work has been done on effects of habitat alteration on interspecific interactions. An example of the HL Fisheries Habitat Research Program is the recently completed studies on the impact of thermal shock on the ability of larval mahimahi to avoid predation. We must increasingly begin to look at such interactions, particularly in the field.

5. Characterize biological productivity of key habitats.

This is also one of the aims of the habitat inventory. Again, it is a difficult goal.

3. Habitat Inventory

An inventory of the marine habitats in the Hawaiian Archipelago was judged a prerequisite to much of the research proposed for the Fisheries Habitat Research Program. The issue of major concern was Inventory (description) of marine habitat types in the Hawaiian Archipelago (issue 9). The inventory is an important tool that will be used as an information base to evaluate the potential impacts of major projects such as ocean dumping, dredge and fill, ocean mining, and OTEC.

A number of other issues relate directly to the inventory. An important question is how to institute a habitat data inventory system (issue 56). This deals with the methods of computer data banking, handling input, and insuring ready access. We must develop and maintain extensive data base system (issue 52) with continuing management of the system once the data base has grown to a large size.

If we are to inventory habitats, then we must be able to measure habitat. How is habitat measured (issue 58)? A great deal of concern was directed at larval and juvenile nursery habitat. This is problematic to define because the juvenile habitats of most tropical fishery resources are unknown. Defining larval and juvenile nursery habitat (issue 12) is important. Obviously, some work is needed in this area in support of issue 9.

Developing the capability for assessing differences in habitat quality and quantity (issue 31) is a difficult but important research area. We can begin to deal with issue 31 once we have defined habitat and developed means of measuring habitat.

A survey of protected species and important habitat types (issue 63) follows logically after issue 31 and results in completion of issue 9. Measuring the productivity and uniqueness of each major habitat type (issue 22) also follows logically in this sequence.

Major Objectives

List and prioritize the resources for which NMFS is responsible in this geographic region. Identify important living marine resources, their abundance, distribution, and productivity. Determine the habitat requirements for these species and the condition of their habitat throughout the Hawaiian Archipelago. This should be presented in a manner that facilitates use of the inventory as a decisionmaking tool.

Significant Events

1. Review existing computer systems for habitat data inventory, select data management system for habitat inventory.

Several data banking and data management systems are already being used in Hawaii. It would be useful to study the possibility of using an existing system.

2. Produce definitive list of major habitat types.

This should include a quantitative and qualitative description of major habitat types. Consideration should be given to physical features (geology, depth, area, salinity, temperature, substrate type, etc.) and to biological features (species composition, density, distribution, etc.). In addition it would be useful to include demographic features (socioeconomic uses, cultural importance, aesthetics, etc.), where possible.

3. Define method of measuring habitat.

The methodology of measuring habitat must be developed early in the project. Existing information will be helpful.

4. Compile existing data on habitats.

A great deal of scattered fisheries habitat data is available. Inclusion of all such data into a common framework would be a significant achievement.

5. Institute habitat surveys to gather additional data where needed.

It is anticipated that review of program needs and existing data will identify areas where additional data are needed.

6. Map distribution, abundance, and productivity of important species.

This would be a useful final product that would be invaluable for habitat planners and managers.

4. Mitigation and Artificial Reefs

As a practical response to the unavoidable loss or damage to fisheries habitat by coastal development, the developer may compensate by substituting in place of the impacted resource a similar resource of equal or greater value. This process, known as mitigation, is attracting increased interest but is still in an early stage of development. The construction of artificial reefs is an especially attractive means of mitigation that has great potential in Hawaii. Such structures have great potential of increasing fisheries productivity in sandy areas but more research is needed. Issue 14 raised an important question, do artificial reefs enhance production or aggregation? This is related to the question about negative effects of FAD's on pelagic resources and abilities to manage related fisheries (issue 10). The concern is that artificial reefs will not actually increase recruitment and production but will simply attract the fish into aggregations and make it easier to overexploit the resource, similar to FAD's. This concern also was expressed about the limiting factors to fish and protected species production (issue 24). The problem of artificial reefs was to establish interaction between recruitment, harvest rate, and trophic basis of support as limitations on artificial reef production (issue 27). Another concern is whether artificial reefs are cost effective (issue 21). Data are lacking in this area, and it will be important to commence actual artificial reef investigations in Hawaii.

Mitigation of adverse habitat effects in Hawaii might include other possible activities. The group was concerned with restoration of habitat (issue 41). Do we have examples of habitats (wetlands, estuarine nursery areas such as Keehi Lagoon and Pearl Harbor, other areas) that could be restored through mitigation? Is fish ranching a mitigation device (issue 61)? The technology for raising and releasing juvenile mahimahi is promising. Could this offset habitat loss as is done with trout, salmon, and other species?

Finally, there is some concern about whether or not mitigation can ever replace loss of some habitats. Even in the best case it may not be cost effective. We need to question whether mitigation is an effective mechanism in insular areas (issue 32).

Major Objectives

Determine if artificial reefs or other potential mitigation devices can serve as effective means of offsetting fisheries habitat loss due to human activity. Determine if artificial reefs increase net fishery production or simply result in fish aggregation.

Significant Events

An experimental deployment of artificial reef structures with a well designed monitoring program might answer some of the questions raised by the planning group. This experimental design should include design of artificial reef structures, selection of site, deployment, and monitoring. In this regard, the Fisheries Habitat Research Program will cooperate with the HL Artificial Reef and Enhancement Program. Specific significant events would be as follows:

1. Develop research plan for artificial reef experiments.

What types of artificial reef structures are available? Where might they be best employed? There is a large amount of information on this topic, but relatively little in Hawaii.

2. Monitor habitat, deploy artificial reefs.

After selection of the site, the area should be monitored before the artificial reefs are deployed. Standing crop and production of commercially important species should be measured.

3. Monitor artificial reefs for recruitment of juveniles and aggregation of adults.

If habitat (shelter from large predators) is limiting the production of bottom fish, then we might increase production by providing artificial reefs as juvenile rearing grounds. Otherwise, we might only attract adults from other areas. This would only aggregate the resource. Routine inspection of the artificial reef for juveniles and adults might answer this question.

4. Produce report on artificial reef experiments.

5. Convene a workshop on effectiveness of artificial reefs in the central and western Pacific, produce a workshop report.

A great deal of artificial reef work has been conducted in Japan, Taiwan, and various areas throughout the world. After further work, and identification of participants, a workshop on artificial reefs could be timely.

5. Ocean Thermal Energy Conversion (OTEC)

The huge volume of cold water brought to the surface from great depths during the OTEC process is likely to impact both pelagic and coastal fisheries habitats. The first Hawaiian OTEC plant is in the design and planning stage and could be operational soon. We are fortunate to have been able to conduct pre-operational research and to have participated in the planning process. This subgroup was mainly concerned with the impact of OTEC on coastal and pelagic resources (issue 38).

Although we are familiar with many of the possible environmental impacts of the proposed OTEC plant, we know relatively little about the impact of possible chlorine or ammonia spills. Large amounts of chlorine gas will be stored for use as a biocide, while ammonia is the working fluid of the plant. Also, relatively little is known about the inshore circulation near the proposed plant.

There are obvious benefits to conducting the inshore current studies simultaneously with scheduled studies of vertical distribution of fish larvae at that site to establish the relationship between larval distribution and currents. This might also provide information on patterns of recruitment of reef fishes.

Major Objectives

To understand the potential habitat threats associated with OTEC to minimize negative impacts on fishery resources.

Significant Events

1. Selection of test species for bioassay work.

The group stressed the need to work with the most appropriate species when doing the bioassay studies.

2. Completion of larval fish vertical distribution work.

3. Completion of the biological section of an environmental impact statement.

4. Complete report summarizing existing site specific circulation data derived from past studies.

5. Complete inshore current study relating plant intake and outfall to the circulation of water over the reef platform and immediately offshore of the reef platform. This should be done simultaneously with larval fish work, if possible. Dye and drogue techniques could be used in shallow water.

6. Complete bioassay work on test species with chlorine and ammonia. This type of research would be useful in other applications throughout the central and western Pacific.

7. Complete attraction, aggregation, and studies of increased fishing effort in collaboration with other tasks. Interpret data and recommend action if indicated.

8. Participate in continuing process of review, public education, public hearings, and future planning particularly to provide input on fisheries habitat issues (see issue 3 on structural chart of the issues).

9. Collaborate in design of monitoring program during construction phase, participate in program, and participate in ongoing process of identification of important habitat issues (issue 3).

6. Ocean Dumping and Mining

Processes involved in ocean dumping and ocean mining frequently produce turbid water and bury, or alter, substrates. These conditions can seriously damage fisheries habitats. Also, there is strong evidence of a link between those conditions and a major public health problem--ciguatera seafood poisoning. This subgroup reviewed all of the issues on the list and came to the conclusion that we had not discussed the key issue of impact of dredging and construction on fisheries habitat. Several items were closely related (see issues 44 and 49) but deal with the cumulative effects of dredge and fill in terms of habitat destruction. We were missing a category for impact of the dredging activity itself (turbidity effects, burial, substrate alteration, etc.). Therefore, we exercised our option to create a new item: Issue 64, "Impact of dredging and construction."

Creation of this category allows us to represent what is believed to be an important linkage between dredging and ciguatera seafood poisonings associated with this activity. It is believed that dredging leads to blooms of the dinoflagellate that produces ciguatoxin (issue 30), which in turn is incorporated into seafood at higher trophic levels (issue 4).

In the general area of ocean dumping, it was obvious that a number of the issues that received no votes could be included in the major categories as follows:

37. Effects of ocean dumping.

Related items receiving no votes:

57. Impact of oil, tar, and dispersants on habitats.

51. Are coastal contaminants a problem?

47. Impact of nuclear waste and disposal, impact of storage.

48. Effects of JACADS.

(These items should be continually monitored and evaluated in the decisionmaking process (issue 3); and they could be included at a later date if conditions in the area indicate this.)

V

42. Ocean mining effects on bottom, sediment discharge effects, and processing effects.

Related items receiving no votes:

1. Sediment effects of ocean mining (combined with 42)

43. Develop a basis for monitoring alterations in deep shrimp habitat.

*46. Relative worth of precious corals versus manganese crust resources.

(*needs further evaluation with data from inventory, etc.)

V

64. Impact of dredging-construction

- turbidity effects (generic study)

- other effects (burial, substrate modification, etc)

V

30. Determine habitat conditions under which algae produce toxic blooms.

V

4. Ciguatera and ecological relationships within the habitat and among species.

Major Objectives

To understand the potential habitat threats associated with ocean dumping, mining, and dredging to minimize negative impacts on fishery resources.

Significant Events

1. Complete literature search and evaluate environmental status of the ocean dumping problem in the central and western Pacific. Provide the input to the decisionmaking process (issue 3). Produce a report on status.

2. List economically important species; produce report.

3. Select species for bioassays of turbidity.

4. Complete bioassay experiments.

5. Develop method (use of submersibles, deep ocean towed camera system?) for monitoring alterations in deepwater shrimp and precious coral habitat.

6. Long-term ciguatera fish poison research and monitoring program established at Midway atoll in collaboration with other groups (this effort will depend upon funding of other groups and improvements in detection methodology).

CONCLUDING REMARKS

The results of this workshop have identified current threats to fisheries habitat in the Hawaiian Archipelago and provide a research strategy organizated into six topical areas. Each area has been discussed in detail and the research questions necessary for its resolution have been addressed. Although program priorities and funding restrictions make only limited progress possible, our better understanding of the research issues and their relationships will allow better program planning and structuring within each topical area.

One area of importance in fisheries habitat research will be the ability to respond to new issues. The issues defined in this workshop are generally those related to current threats, although many (particularly the baseline studies and long-term ecological research) are basic to any habitat threats. Two issues raised in the discussion were the focus of discussion on how the HL can respond to new habitat threats or research needs. Selection of environmental problems and solutions (issue 3) stresses the ability to identify habitat issues and research approaches; on

Figure 2, this issue is shown at the bottom as an ongoing process. Analysis versus research -- when to do what (issue 16), when combined with issue 3, resulted in discussion of mechanisms to identify new threats and how to define whether sufficient data are available or if further research is necessary.

Certain issues, including several discussed at the meeting, may currently have low priority, but renewed or altered activities by man which alter fisheries habitat may make the issue critical and timely for the Fisheries Habitat Research Program. As these issues arise, our approach will be to first assess the habitat threats and their priority with respect to current program activities. Convening of interagency groups can serve to define the issues, discuss objectives and research needs, and, in the manner of the present workshop (but perhaps on a more limited basis), identify the respective roles of NMFS and other agencies in conducting research to resolve the problems.

APPENDIX 1

Development of an FY 1985 Fisheries Habitat Research Program

The Honolulu Laboratory Fisheries Habitat Research Program was funded to begin in January 1985. Program design for FY 1985 was undertaken with only limited planning. The intent was to develop a program which fit the context of the NMFS habitat conservation and research policy but tailored to the habitat issues of the Hawaiian Archipelago. In developing the program, guidance was provided by several general policy documents including the following:

1. Habitat Conservation: Policy for the National Marine Fisheries Service (NMFS) (Federal Register, 25 November 1983).

2. NMFS Habitat Conservation Policy: Guidance for Implementation Strategies (Office of Protected Species and Habitat Conservation, 23 May 1984).

3. Marine Environmental Quality: Task Force Report (NOAA, June 1984).

These documents outline NOAA's objectives in the area of marine environmental quality, which include the following:

- To protect the health of the nation's seafood consumers and other users of the marine environment.

- To protect the health of ecosystems from degradation that could adversely affect the health or productivity of living marine resources.

- To improve, through research and assessments, our understanding of the consequences of pollution and habitat alteration and provide a sound scientific basis for public policy and management decisions.

- To promote balanced decisionmaking for multiple use of the marine environment.

Although these overall objectives provide guidance to general program structure and goals, man's activities impact fisheries habitat in many ways which differ from region to region. The NOAA has defined a series of habitat alteration "opportunity" areas which are clearly relevant to any program in fisheries habitat research. These include the following:

- Preapplication consultation

- Mitigation banking

- Artificial reefs

- Habitat enhancement, restoration, and construction

- Marine and estuarine habitat valuation procedures

- Marine and estuarine sanctuary designation

- Inventory coastal habitat distributions and sensitivities, resource distributions, and developmental activities

- Focus research on ecological processes and effects of habitat alteration

Many of these areas are clearly relevant to the Fisheries Habitat Research Program in the Hawaiian Archipelago and the central Pacific Ocean. Thus our own studies of fisheries habitat and information in several regional studies, both ongoing and published, were also used, including the following documents with input from HL personnel:

1. The Potential Impact of Ocean Thermal Energy Conversion (OTEC) on Fisheries (NOAA/OCRM/Ocean Minerals and Energy, July 1984).

2. Summary of Pertinent Biological Characteristics of Potential Ocean Thermal Energy Conversion (OTEC) Sites in the Pacific Ocean (R. N. Uchida, SWFC Admin. Rep. H-83-13).

3. Potential Impact of Deep Seabed Mining on the Larvae of Tunas and Billfishes (W. M. Matsumoto, NOAA Tech. Memo. NMFS-SWFC 44).

The specific research projects decided upon for FY85 were in five general areas, namely those associated with Ocean Thermal Energy Conversion (OTEC), manganese crust mining, ciguatera research, habitat enhancement and mitigation, and long-term ecological research. In addition to these areas, we have initiated a modest program of habitat evaluation, defining the areas and associated resources throughout the Hawaiian Archipelago to provide a more complete inventory of habitat types. We have continued our attempts to define habitats for juveniles or possible critical nursery areas for commercially important species and also initiated selected nearshore research to identify characteristics of marine turtle habitat in the main Hawaiian Islands.

The planned research program was thus designed to consider habitat conservation issues of importance to NOAA-NMFS applied to the Hawaiian Archipelago. The chief exception was the exclusion of potentially important issues concerning chemical pollutants. In the initial program the decision was to pursue fisheries and ecologically oriented habitat issues concordant with the expertise of the HL staff. This allowed us to initiate a meaningful research program for FY85 on short notice.

APPENDIX 2

Members of the Ad Hoc Interagency Task Force for Planning the Honolulu Laboratory's Fisheries Habitat Research Programs

1. Dr. George W. Boehlert, Chief, Insular Resources Investigations, Southwest Fisheries Center Honolulu Laboratory

2. John F. Carr, Deputy Director, Southwest Fisheries Center La Jolla Laboratory

3. Dr. Edmund S. Hobson, Chief, Fisheries Environment Investigation, Southwest Fisheries Center Tiburon Laboratory

4. Paul L. Jokiel, Acting Task Leader, Fisheries Habitat Research Program, Southwest Fisheries Center Honolulu Laboratory

5. Dr. Craig D. MacDonald, State of Hawaii, Department of Planning and Economic Development, Ocean Resources Branch, P. O. Box 2359, Honolulu, Hawaii 96804

6. Eugene T. Nitta, SWR Western Pacific Program Office

7. Dr. James Parrish, Leader, Hawaii Cooperative Fishery Research Unit, University of Hawaii, 2538 The Mall, Honolulu, Hawaii 96822

8. Dr. A. Dean Parsons, Office of Resource Investigations, National Marine Fisheries Service, NOAA, Washington, D.C. 20235

9. Dr. Jeffrey J. Polovina, Task Leader, Artificial Reef and Enhancement Program, Southwest Fisheries Center Honolulu Laboratory

10. Dr. Stephen Ralston, Task Leader, Insular Stock Assessment Program, Southwest Fisheries Center Honolulu Laboratory

11. Henry M. Sakuda, Director, State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources, 1151 Punchbowl Street, Honolulu, Hawaii 96813

12. Richard S. Shomura, Director, Southwest Fisheries Center Honolulu Laboratory

13. Dr. Jerry A. Wetherall, Chief, Pelagic Resources Investigations, Southwest Fisheries Center Honolulu Laboratory

Facilitator: David J. Mackett, Planning Officer, Southwest Fisheries Center La Jolla Laboratory

Recorder: Dr. John T. Harrison, Fishery Biologist Southwest Fisheries Center Honolulu Laboratory

APPENDIX 3

SWFC Honolulu Laboratory Fisheries Habitat Research Program Background Material for Planning Session May 1985

The National Marine Fisheries Service (NMFS) Southwest Fisheries Center (SWFC) Honolulu Laboratory (HL) was tasked to develop a program of "vital fisheries habitat research in the Pacific." This document describes 1) specific research activities undertaken in the first year of the project (FY85), and 2) future plans for habitat research in Hawaiian waters with emphasis on year 2 of the project. The planned research program addresses habitat conservation issues of importance to NOAA-NMFS which are relevant to the Hawaiian Archipelago. While concentrating on issues concordant with the expertise of the HL staff, the program has responded to specific needs by hiring temporary staff. The purpose of this document was to provide background information to a planning meeting which was held on 27-28 June 1985.

The FY85-86 Habitat Research Program at the Honolulu Laboratory

Most of the projects undertaken to date have a duration of less than 2 years. Initial research efforts considered effects of current marine construction (e.g., dredging at Barbers Point) and planned activities such as the Kahe Point Ocean Thermal Energy Conversion (OTEC) Plant and manganese mining. Additional habitat issues related to threatened and endangered species also have been addressed. The design of the program, however, was such that longer range planning would take place during the first year, after key program personnel were in place. Our plans for staffing were to involve relatively few permanent employees and to initiate work with temporary employees and IPA assignments. The role of acting task leader was taken by Paul L. Jokiel on a temporary appointment. In addition to supervising ongoing research, the task leader has contributed to a strategic planning session, encompassing the second year of the project and longer range programmatic research.

The specific research projects described below fall into five categories: OTEC, manganese crust mining, ciguatera research, habitat enhancement and mitigation, and long-term ecological research. In addition, we have initiated a modest program to define areas associated with important resources throughout the archipelago and to provide a more complete inventory of habitat types. Habitats for juveniles and possible critical nursing areas for commercially important species are specific concerns of the latter effort. Selected nearshore research projects to identify critical characteristics of marine turtle habitats in the main Hawaiian Islands complete the program inventory.

1. OTEC related research

The HL has kept apace of developments in OTEC and has provided background documents in collaboration with the NOAA Ocean Minerals and

Energy Office (OME). Dr. John T. Harrison is preparing biological sections of the Kahe Point OTEC Environmental Impact Statement, and is responsible for identification of OTEC-related biological impacts requiring additional evaluation. Increasing levels of community concern in the Waianae district over OTEC impacts to the region virtually guarantee an extensive public hearing process attendant upon OTEC implementation. Dr. Harrison will be available to provide expertise on biological aspects of OTEC impacts, at public hearings and at interagency planning and evaluation meetings.

As currently proposed, the OTEC facility would redistribute unprecedented volumes of warm surface water and cold water from a depth of 700 m, requiring about 100 m^3 per second of each. Specific areas of concern include impingement and entrainment of organisms, thermal discharges, working fluid and biocide releases, sand transport, construction effects, and attraction or repulsion of fishes. Model predictions of OTEC influences on nutrient redistribution and fish population dynamics have suggested avenues of research.

One key area of OTEC research is a baseline study of vertical distribution of ichthyoplankton off Kahe Point, Oahu. This area was identified by Miller (1978) as having high densities of tuna larvae. Describing vertical distribution of fish larvae will allow analysis of potential entrainment- and impingement-associated mortality as well as possible effects of the discharge plume on these organisms. This work will continue into FY86.

During FY85 experiments were conducted on larval mahimahi to determine their response to thermal shock. A great deal of information exists on effects of raised temperature on fishes, but cold thermal shock has only recently been considered. This is especially of concern for economically important tropical marine species. Our initial experiments on lethal and sublethal effects (e.g., increased vulnerability to predators) have been completed. This work might be carried into FY86.

Movement and migration patterns of different species of deep bottom fish are topics which remain undefined. This research is important to several other areas of research (artificial reefs, management practices, recovery in dredged areas), but particularly to the OTEC study. The OTEC cold water pipe may provide an important attractive element to bottom fish communities, particularly in the area of increased benthic enrichment due to fallout of entrained organic material. Extant models of OTEC's impact on fisheries do not specifically consider the role of the pipeline in attracting bottom fish from adjacent areas and the possible result of increased exploitation of the resource. It is important to know if commercially important bottom fish remain in a given habitat over time or if they move among habitats. Snappers and groupers show an extremely "patchy" distribution on the reefs. Knowledge of the reasons for this would be useful in management of the fishery.

2. Manganese crust mining related research

The Minerals Management Service (MMS) of the Department of the Interior is considering leasing tracts within the Hawaiian Archipelago for exploitation of manganese crusts. These crusts are more enriched in cobalt than are manganese nodules and thus of greater economic value. Generally, the farther northwest one goes in the archipelago, the thicker the crusts become. For this reason, and since the population centers are to the southwest, the strongest potential mining sites within the exclusive economic zone (EEZ) are the seamounts near and northwest of Midway. Dredging studies have been conducted on these seamounts to assess the presence and quality of the minerals, but no biological studies have been conducted on potential impacts, particularly those related to fisheries. Several concerns exist, including habitat destruction, effects of sediment plumes associated with processing, heavy metals, and benthic sedimentation effects.

We have commenced laboratory research into effects of sediment on the feeding of larval and juvenile mahimahi. This program is clearly relevant to manganese crust and nodule mining in deep ocean areas away from land. This work is being conducted at the Kewalo Research Facility and will be continued into FY86. Processed waste tailings could be much more toxic than sediment and pulverized crust, depending on the processing method employed. Processing alternatives should be studied to determine the least detrimental technique.

Field and laboratory studies on potential impacts of manganese crust mining will continue. First, an expanded field reconnaissance and habitat description will be necessary to better understand the location and extent of the resource. The depths impacted directly by deepwater mining are inhabited by deepwater shrimp (Heterocarpus spp.) and precious corals. In the seamount region, pelagic armorhead and alfonsin may also occur during some times of day at depths susceptible to mining-related impacts. Planned submersible research in the Seamount Resource Study could be complemented by additional dives, deep-sea camera drops, and possibly remote video assessment of these habitats to better understand the behavior and distribution of these resources by habitat type. Other field research which relates to mining impact is the study of movement and migration mentioned previously. This knowledge could aid in our understanding of the biological capability of certain species to move from impacted habitats and occupy habitats after impacts were ameliorated.

3. Ciguatera research

There is continuing concern in Hawaii that man's activities in the coastal and nearshore environments cause outbreaks of ciguatera poisoning. Specific cases have been documented, but there also are cases of poisoning in pristine waters in the absence of activities such as dredging. Most of the past research in Hawaii on ciguatera has centered on detection methodology, food chain pathways for the toxin, and on determination of the species affected. Relatively little effort has been directed at establishing the environmental conditions that cause local outbreaks.

During FY85 we collaborated with Dr. Y. Hokama, of the University of Hawaii, in the evaluation of his newly devised "stick test" for ciguatoxin. We are participating in an evaluation by the Association of Official Analytical Chemists and are running an independent evaluation at Midway atoll this summer. Also, we are keeping ourselves informed of recent ciguatera outbreaks and recent scientific advances in the field.

A major problem with previous ecological work is that studies did not commence until after an outbreak was reported. Events leading to the outbreak were long past. A major conclusion of the ciguatera workshop held at the Honolulu Laboratory was that long-term studies at a single location are needed. Midway atoll would be an ideal site for such studies because it is small, restricted, subject to frequent outbreaks, and readily accessible to our staff. Tide, water temperature, water density, meteorological variables and other factors are already being recorded. We would monitor blooms of the macroalgal substrate, blooms of the toxic dinoflagellate, Gambierdiscus toxicus, that follow the macroalgal blooms, toxicity of herbivorous fishes and toxicity of carnivorous fishes at the atoll. We could then establish spatial and temporal relationships among these factors. Use of the stick test simplifies the work, especially if the local base doctor or other responsible local officials would test fish for the residents as a public service. These records could greatly expand our baseline studies. We would want to continue for several years with quarterly sampling as a minimum.

We also could conduct "food-chain" amplification studies at the Kewalo Research Facility by feeding toxic flesh from Midway fishes to nontoxic fishes and observing the rate of toxin accumulation. Drs. Hokama and Scheuer of the University of Hawaii are very involved with the biochemistry of this toxin, but do not have the capacity to conduct the ecological investigations. We could provide them with this capacity in exchange for collaboration on analysis.

4. Habitat enhancement and mitigation research

Habitat enhancement along the coasts of the mainland U.S. generally involves revegetation of wetlands lost to development. This is not usually considered applicable to the pristine waters of Hawaii. There are, however, very large areas of unproductive habitat which could be improved to enhance local fish production. Much of the shelf area of Penguin Bank, for example, lacks suitable cover and is devoid of fish. Dr. Polovina will soon deploy a large artificial reef in this area and will monitor it to determine if it does enhance the habitat. It is hoped that this program can be expanded as part of the FY86 project. As habitat is lost to development, mitigation of habitat loss through deployment of artificial structures remains one of the few options in the limited coastal ecosystem of the Hawaiian Islands. This task will thus cooperate with the Artificial Reef Study, where possible, to consider the application of general results to mitigation activities.

The planned studies on movement and migration of bottom fishes will also provide input to that study by allowing better understanding of recruitment of fishes to new habitats. Future plans within the Fisheries Habitat Research Program may include economic studies on mitigation, how artificial reefs change recreational and commercial fishing behavior, or on economic losses associated with habitat loss in localities such as Barbers Point.

Understanding habitat requirements of threatened and endangered species is also critical to evaluation of the impact of human activity on those species. Green turtles and hawksbill turtles live in nearshore habitats most of their lives, leaving for only relatively short periods to migrate to breeding areas. These turtles are known to have a restricted "home range" in this nearshore habitat. Coastal development by man and other factors have impacted these nearshore feeding and sleeping areas. Research is presently being conducted as part of the FY85 effort to define the habitat characteristics which make certain sites preferred and how best to maintain the health and productivity of these habitats. This could lead to management decisions on multiple use of nearshore environments, which would conserve endangered marine resources and provide baseline data for habitat conservation, mitigation, and restoration.

5. Long-term habitat research and monitoring

The overall goals of long-term ecological research will be to provide baseline data for detection of habitat or environmental change. In general, data collection plans and program objectives are being formulated in the first year of the study. The need for long-term studies of ciguatera in relation to the environment is one example.

For several years, the HL has cooperated with the U.S. Fish and Wildlife Service (FWS) to study feeding ecology of seabirds in the Northwestern Hawaiian Islands. Continuation of this program could contribute to the Fisheries Habitat Research Program by providing a potentially sensitive indicator of environmental change. We are exploring future cooperation with the FWS.

In addition, we anticipate contributing to a continuation of the existing research of Dr. Ted Hobson, of the SWFC Tiburon Laboratory, who has conducted research at Kona for nearly two decades. A small expenditure would insure continuation of this time series study following the distribution and abundance of reef fishes on the relatively undisturbed reefs of Kona.

6. Habitat inventory and evaluation

We are looking into the possibility of instituting a system to keep track of habitat data taken throughout the archipelago, but this is a matter for further discussion. Much data are being collected on the resources of the area and it might be useful to compile all such data in a single reference frame for future reference. This data base would supply a quantitative means of habitat evaluation in future years.

7. Areas not being considered at the present time

Habitat issues beyond the present scope of this project include the effects of oil spills, chemical waste disposal, and disposal of radioactive waste at sea.

APPENDIX 4

Agenda for the Fisheries Habitat Planning Workshop, 27-28 June 1985
Honolulu Laboratory of the Southwest Fisheries Center
(NGT = Nominal Group Technique)

Thursday, 27 June 1985

Time	Agenda item	Person responsible	Process
0920	Welcome, introductions, purpose of planning workshop	Richard Shomura	
0925	Current overview of fishery habitat threats, preservation and research		
	- Program strategy for FY85 and results to date	George Boehlert	
	- Comments on trends in habitat research	Dean Parsons	
	- Status of HL program today and for FY86	Paul Jokiel	
1000	Identification of major habitat issues	Group facilitated by Dave Mackett	NGT
1100	Coffee break		
1115	Finish issues		
1200	Lunch		
1315	Development of criteria for a) NMFS mission purview b) Selection of issues	Group	
1430	Selection of issues	Group	Group vote
1530	Appoint subgroups to formulate objectives		
	Group adjourns except for the subgroup working on the structural model		
1545	Input the issues into the ISM structural model on VAX computer	Mackett, Boehlert, Jokiel, Nitta, Harrison	ISM
2000	Finish		

Friday, 28 June 1985

Time	Agenda item	Person responsible	Process
0900	Review of previous work	Dave Mackett	
0910	Meaning of the structure of the issues shown by first output diagram - how the diagram was made - meaning of resulting diagram - review and comment		
1000	Divide into three subgroups, give subgroups instructions		
1045	Subgroup work (see below)	Subgroup chairmen	Committee
1420	Subgroup reports - Long-term ecological research - Mitigation/artificial reefs/ inventory - OTEC/ocean mining	Subgroup chairmen - Ralston - Nitta - Jokiel	
1530	Final wrap-up		
1600	Adjournment		

SUBGROUPS

Subgroup Area of responsibility	Members
Baseline studies and long-term ecological research	Hobson, Parsons, Ralston, Shomura
Habitat inventory, mitigation, and artificial reefs	Carr, MacDonald, Nitta, Sakuda
OTEC and ocean mining and dumping areas	Harrison, Jokiel, Parrish, Wetherall

APPENDIX 5

Identification of Major Habitat Issues

The NGT process was described and the first task was identification of the major habitat issues. To focus participants' thoughts on the problems at hand, a draft trigger question was proposed and then, after discussion, clarified to the final form, as follows:

"In the context of developing a 5-6 year research program what are the important current and emerging issues (problems, threats, man-induced, non man-induced) concerning central and western Pacific fisheries habitat that need to be resolved?"

After clarification of the trigger question, the group silently generated ideas (issues); this 15-minute period was followed by a round-robin listing of the ideas without discussion or criticism. The next step was clarification of ideas; during this step, some ideas were modified, merged with others, or deleted. The final list of issues and their clarifications were taken from notes of the meeting recorder and notes of other group members as follows:

1. Deleted

2. **What variation can be expected from natural forces?**

Group discussion:

We cannot evaluate the impact of human activity on a habitat without an understanding of the complete range of natural variability in the physical and biological environments. This would encompass all variability other than that imposed by human activity. Otherwise we might mistake long-term natural trends as the result of human activity.

3. **Selection of environmental problems and solutions.**

Group discussion:

This issue emphasizes the importance of the ongoing process of identifying important habitat issues and their solutions. Original research is not always the solution. Literature reviews, synthesis of existing data, contributing directly to decisionmaking processes in society, and participation in the educational process are important alternatives.

4. **Ciguatera and ecological relationships within the habitat and among species.**

Group discussion:

This question is closely related to issue 30. Issue 30 is concerned with production of the toxin in the lowest trophic level, but issue 4 is concerned with transfer of the material through higher trophic levels.

5. **Conceptual model for all possible outcomes of resource and habitat interactions.**

Group discussion:

It is important to consider all ramifications of a potential problem early in the planning stage. It is useful to form a conceptual model of these many interactions at the outset.

6. Deleted.

7. **Alteration of freshwater intrusion into coastal water.**

Group discussion:

Diversion of freshwater stream inflow from estuarine nursery grounds for irrigation purposes has occurred and will continue to be a habitat threat in the future. Also, rupture of aquifers by large-scale coastal construction projects such as the Barbers Point Deep Draft Harbor modifies patterns of coastal freshwater intrusion and could pose a habitat threat.

8. **What larval species is a suitable laboratory "white rat?"**

Group discussion:

It is important to select appropriate species as laboratory subjects for experiments concerning effects of habitat alteration, before experiments are designed. Economically important species would be preferred. Also, one has to consider which species and which life stage of that species are most likely to be adversely influenced by the habitat alteration being considered.

9. **Inventory (description) of marine habitat types in the Hawaiian Archipelago.**

Group discussion:

This issue is related to issue 6. It will be important to identify the level of detail (e.g., protected species habitat) that we want to describe.

10. **What are negative effects of FAD's on pelagic resources and abilities to manage related fisheries?**

Group discussion:

This question is analagous in some respects with issue 14 which asked if artificial reefs enhance production or simply aggregate the fish and make it easier for man to deplete the resource.

11. **What are habitat requirements for important species (including protected species?)**

Group discussion:

This issue encompassed issue 6. What do specific organisms need? The group decided to use the widest possible definition and include all biotic as well as abiotic factors into the definition of habitat. This definition includes the physical aspects of the habitat requirements of the organism in question and all supporting ecosystem requirements.

12. **Define larval and juvenile nursery habitat.**

Group discussion:

This item is clearly related to issues 11 and 6. This item is part of 11, but will not be combined with 11 at this time because it seems to be important enough to stand alone as a separate question.

13. **What changes (abundance and species complex) in coastal and pelagic resources result from changes in size of human habitation on islands?**

Group discussion:

This item asks questions concerning the overall impact of human activity on the nearshore environment. Fish were excluded because of the obvious impact of human fishing pressure. This issue is more concerned with subtle long-range effects that are hard to define because they are the cumulative result of many individually insignificant factors.

14. **Do artificial reefs enhance production or aggregation?**

Group discussion:

Artificial reefs could have a positive or negative effect. They might increase recruitment by juveniles that are limited by protective habitat and thereby increase total fish production. Conversely they might only serve to aggregate the existing resource and make it far too easy for overexploitation of the resource (increase catchability with the same gear). As an example, if the OTEC intake pipe serves as an artificial reef, it might attract fishermen as well as fish and thereby deplete the resource.

15. **What are the capabilities of the various marine organisms to avoid human disturbance?**

Group discussion:

This item is related to issue 8 and is the inverse of issue 19. Issue 19 deals with the ability of a habitat to withstand human disturbance. Issue 8 asks what is the best test species. Some species will be able to move away from an area of local disturbance and return later.

16. **Analysis versus research—when to do what.**

Group discussion:

This item is related to issue 3 which deals with the process of deciding upon issues that will be studied and how these issues will be studied. The major point made here is that original research is not always the best approach if one can find the answer by a synthesis of previously published results.

17. **Evaluation of factors affecting relationships of recruits and source stocks.**

Group discussion:

This item is related to issue 33 which asks how we select long-term recruitment indicators and issue 35 which asks how we might determine local recruitment of pelagic resources. The recruitment problem is a difficult one facing most tropical fisheries—it is difficult to locate nursery areas and to measure recruits.

18. **Evaluate benefits of public education with respect to habitat issues.**

Group discussion:

This item is related to issue 29 on how to influence environmental decisions. It is also related to other decisionmaking issues (e.g., 3, 5, 16, and 54).

19. **What are capabilities of marine organisms to accommodate habitat modification?**

Group discussion:

This issue is related to 15 which questions the ability of a given habitat to accommodate human impact. It would be difficult to deal with these questions because the concept of "marginal" habitat is introduced. The organism in question might be able to withstand the change, but it will be in a less optimal environment and will be less productive. Growth rate and reproductive rate might be diminished, even though the organism can tolerate the change.

20. **What are the effects of military maneuvers?**

Group discussion:

There is a great deal of military activity in Hawaiian waters. Amphibious training exercises, practice bombing, and accidental or deliberate dumping of ordinance has an unknown, but possibly important, impact on some nearshore areas. This concern is related to many items dealing with the individual and combined importance of many human activities (i.e., see issues 44, 55, 62, 45, 36) and also ocean dumping (issues 37, 51, 48).

21. **Are artificial reefs cost effective?**

Group discussion:

The potential value of artificial reefs as mitigation devices will depend on cost effectiveness. This issue is related to others dealing with mitigation and artificial reefs (see 32, 41, 14, 27, and 50).

22. **Measure of the productivity and uniqueness of each major habitat type.**

Group discussion:

This question was directed at emphasizing the importance of "quality" as opposed to "quantity" of habitat. This was the first question dealing with habitat productivity. Issue 22 ties issues 6 and 11 into issue 9. Problems with providing a definition for "uniqueness" subsequently led to problems in interpretation of this question.

23. **What are the effects of vessel traffic-harassment, etc., on humpback whales?**

Group discussion:

This item is related to issue 6, which asked the nature of protected species habitat. It also is related to issues 11 and 9.

24. **What are the limiting factors to fish and protected species production?**

Group discussion:

The value of this question is that if we can determine what is restricting production, then we may be able to take steps to alleviate selected problems.

25. **How do introduced species and aquaculture releases impact fishery habitat?**

Group discussion:

Introduced species have greatly altered many Hawaiian habitats. The taape or blue-lined snapper has become extremely abundant in the archipelago. Other examples are mangroves, Japan oyster, and Virginia oyster.

26. Deleted.

27. **Establish interaction between recruitment, harvest rate, and trophic basis of support as limitations on artificial reef production.**

Group discussion:

This is related to issue 14 which deals with production-aggregation of fish by artificial reefs. This issue, however, is more concerned with the ultimate trophic basis of support for an artificial reef.

28. **Does loss of individuals (mortality) from human disturbance have significant impact on populations of that species?**

Group discussion:

This item raises a question as to vulnerability of different species to human impact. Obviously some populations will be more vulnerable than others. Moreover, the impacted area may be an insignificant part of a species range.

29. **Marketing techniques—ways of influencing environmental decisions with information.**

Group discussion:

This issue is closely related to issue 18 (value of public education in influencing decisions).

30. **Determine habitat conditions under which algae produce toxic blooms.**

Group discussion:

This is related to issue 4, but 4 deals only with trophic interactions above the primary producer level. This issue deals with the production of toxin at the lowest trophic level.

31. **Develop capability for assessing differences in habitat quality and quantity.**

Group discussion:

This overlaps with issue 22 which deals with habitat "uniqueness" and "productivity" of different habitats.

32. **Is mitigation an effective mechanism in insular areas?**

Group discussion:

Perhaps some types of habitat loss can never be mitigated, but we must know effectiveness of various mitigation schemes at replacing lost valuable habitat. This is closely related to other mitigation related issues (61, 41, 21, 53, etc.).

33. **What are long-term recruitment indicators?**

Group discussion:

Perhaps we could determine some relatively easy and inexpensive ways to monitor long-term recruitment trends to give an indication of what is happening offshore. Use of "model" species of inshore or reef fishes could reflect trends in important reef fishes. This is related to issues 17 and 35.

34. **List of economically important marine organisms that could be impacted by man's activity in nearshore area.**

Group discussion:

We should identify the inshore and pelagic species that are economically important either directly or as forage species. All life stages should be considered. This is closely related to issues 11 and 6 which deal with habitat requirements for these organisms.

35. **What determines recruitment of local pelagic resources?**

Group discussion:

This is related to issues 17, 33 and 5. Again, the recruitment issue is an especially important one in tropical fisheries where such data are generally lacking. For pelagic resources, the issues of recruitment are somewhat different from those for insular resources.

36. **Impact of fishing practices on fish habitat.**

Group discussion:

Some fishing practices destroy the habitat. The most notorious have been outlawed (using Chlorox, dynamite fishing), but others might be important. Dragging of anchors, effect of discarded gear, and ghost fishing traps are possible negative factors.

37. **Effects of ocean dumping.**

Group discussion:

This is a broad category which can include dredging and disposal of ocean mineral mining waste, chemical contaminants, oil and tar, nuclear waste, and the Johnston Atoll Chemical Agent Disposal System.

38. **Impact of OTEC on coastal and pelagic resources.**

Group discussion:

This is generally seen as an important issue. It is closely related to issue 39, which deals with accidental spills of biocide or working fluid and issue 60 which deals with the problem of inshore circulation at Kahe Point. Issues 39 and 60 were eventually combined with 38 by the working subgroup.

39. Deleted.

40. **What are important interspecific relationships of organisms likely to be affected by habitat disturbances?**

Group discussion:

It is posible that disturbances that do not kill an organism might severely influence the population by interfering with other biological interactions (predation, disease, etc.).

41. **Restoration of habitat.**

Group discussion:

Is it really feasible to restore or recreate affected habitats? This is related to issue 32 on the cost-effectiveness of mitigation.

42. **Ocean mining effects on bottom habitat and processing effects.**

Group discussion:

Ocean mining may have a wide range of effects, from sediment smothering to toxic metal effects. Issue 43, which deals with ways to monitor effects of ocean mining on deep water habitat, is directly related to 42.

43. **Develop a basis for monitoring alterations in deepwater shrimp habitat.**

Group discussion:

We should start to develop techniques for monitoring the impact of deep mining on the bottom communities. Use of submersibles or deepwater cameras looks promising.

44. **What are cumulative impacts of dredge and fill operations and how are they measured?**

Group discussion:

Many permits are issued for small dredge and fill operations in the central and western Pacific and there is a long history of such operations in Hawaii. The cumulative effect of many smaller projects should be evaluated and long-term trends of habitat loss thereby established.

45. **Effects of coastal development.**

Group discussion:

This issue was directed at impact of large residential or hotel developments along the coast and is related to many other issues dealing with coastal development (e.g., 13, 23, 62, 44).

46. **Relative worth of precious coral versus manganese crust resources.**

Group discussion:

The habitat inventory (issue 9 and related ones) will assist in analyzing this issue. Some areas may be more appropriate for mining based upon living resource distributions. Also, work must start on issue 43 (means of monitoring mining) before we can evaluate the relative importance. At this time the precious coral is not being harvested in the Exclusive Economic Zone (EEZ) and the areas that are to be mined are remote.

47. Deleted.

48. Deleted.

49. **Long-term trends in habitat loss in Hawaii.**

Group discussion:

This is closely related to issue 44, but is not restricted to dredge and fill types of loss. Issue 44 is a subset of 49.

50. **What are diel and seasonal variations in distribution and abundance of important species?**

Group discussion:

This represents another type of variation that must be evaluated before we can determine the effects of human activity. This issue has special application to artificial reef aggregations which often represent resting schools. These are present during daytime but may disperse at night to feed.

51. Deleted.

52. **Develop and maintain extensive data base system.**

Group discussion:

The habitat inventory will require a computer data base that must be managed properly. The system must be designed to receive the many types of data that are available and must be simple to access. This question is closely related to issue 56 (How to institute a habitat data inventory system).

53. **Alleviate adverse habitat effects on baitfish.**

Group discussion:

Baitfish production (nehu and other species) is a limiting factor for the pole-and-line tuna industry in the central and western Pacific. In Hawaii, baitfish grounds are restricted largely to Pearl Harbor and Kaneohe Bay. Both areas are under considerable environmental pressure from development in other areas (waste discharge, military activity, urbanization, etc.). Perhaps

mitigation is a possibility in this area.

54. **What will be the role of NMFS in providing habitat research and management support to the territories and compact states?**

Group discussion:

During FY85 and FY86 the HL Fisheries Habitat Research Program focused on studies in Hawaii. This was due largely to the fact that the major environmental problems identified (OTEC, ocean mining, etc.) will occur in the Hawaiian Archipelago. However, environmental problems will also develop in the compact states, American Samoa, Guam, and other areas that fall into our purview. The WPPO is constantly faced with evaluating new projects that impact fisheries habitat. How will we address these issues in the future?

55. Deleted.

56. **How to institute a habitat data inventory system.**

Group discussion:

This is an important "nuts and bolts" question that must be accomplished before we can deal with issue 6 (nature and extent of habitat) and issue 9 (inventory of habitat types). Suggestions were made that HL investigate the type of system currently being used by DLNR.

57. Deleted.

58. **How is habitat measured?**

Group discussion:

Before we can inventory habitat, we must have some idea of how to measure habitat. This issue is prerequisite to many other items dealing with the habitat inventory (issues 56, 31, 9, 52, 63, 22, and 6).

59. **Are mass mortalities of reef fish habitat-related?**

Group discussion:

This issue focuses on the recent mass mortalities of the triggerfish (Pervagor) that have occurred throughout Hawaii. This seems to happen every 5 to 10 years and is believed to be related to unusual environmental conditions. Could this give us some important information on habitat?

60. Deleted.

61. **Fish ranching as a mitigation device.**

Group discussion:

Recent success in closing the life cycles of tropical marine fishes of economic importance (such as the mahimahi) raises the possibility of stocking natural waters with juvenile fishes. What information do we need to evaluate the value of fish ranching? Could this serve to offset losses in habitat? Can it be used to mitigate environmental damage?

62. **Impact of anti-erosion devices.**

Group discussion:

This is yet another example of a number of related issues dealing with coastal development (e.g., 45, 7, 20, and 44). Positioning of these devices might alleviate erosion, but will influence the habitat.

63. **Survey of protected species and important habitat types.**

Group discussion:

Identification and preservation of the habitat of protected species is critical. The FY85 Fisheries Habitat Program supported studies of turtle feeding grounds in Hawaii. What other protected species habitats should be identified and surveyed?

64. **What is the impact of dredging and construction in coastal environments?**

Group discussion:

This question was added by the working subgroup. We did have other issues related to dredging (44 dealt with cumulative habitat loss), but we did not have one specific to inshore sediment plumes and other problems of a generic nature associated with dredging and coastal construction. Creation of this issue allowed the subgroup to tie the ciguatera problem (issues 4 and 30) into the rest of the scheme. It is believed that seafood poisonings are often associated with dredging activity and coastal construction.

APPENDIX 6

Voting on the Issues

After clarification and discussion of the issues, each participant was allowed five votes and ranked the five selected issues in order of importance from 1 to 5, 1 being most important. The issues were then ranked according to their importance as determined by the group vote. The order in which the issues are entered in the program will not influence the final outcome but can be used to best schedule the time for conducting the structuring of issues. It also ensures that those issues deemed most important by the group will be addressed if time runs out. All issues that received votes were eventually entered into the program as follows:

Entered	Issue No.	Votes	
1	38	1,1,1,2,2,2,2,2,4,4	
2	2	1,1,2,3,4,5	
3	11	1,1,1,1,2,2,2,3	
4	9	2,2,3,3,4,4,5	
5	5	1,1,3,5	
6	42	1,2,3,3,3	
7	3	4	
8	4	4,5	
9	6	3,1	(later deleted, included in 11)
10	8	4	
11	14	5	
12	16	5	
13	22	3	
14	24	4	
15	27	5	
16	28	3	
17	31	2	
18	32	4,3	
19	34	5	
20	37	5,4,3	
21	40	5,4	
22	48	5	(later deleted, included in 37)
23	49	5	
24	56	5	

All other items received no votes. These issues were then entered into the ISM program to determine the relationship among the factors as shown in Figure 1.